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CENTRAL INTELLIGENCE AGENCY

INTELLIGENCE MEMORANDUM NO. 344
(CIA/RR IM-344)

WORLD PRODUCTION AND DISTRIBUTION OF ABRASIVES

19 March 1951

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Note: This report has not been coordinated with the intelligence organizations of the Departments of State, the Army, the Navy, and the Air Force. It contains information available to CIA as of 1 March 1951.

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WORLD PRODUCTION AND DISTRIBUTION OF ABRASIVES

1. Introduction.

North America (US and Canada) possesses a high degree of self-sufficiency in abrasives, producing about 64 percent of the world total and supplying Western Europe with practically all of its imports, amounting to about 40 percent of requirements. In the Eastern bloc the Satellites are in varying degrees largely dependent for their abrasives on the West, and the USSR also relies chiefly on the West for specialized abrasive products. Restrictions on the movement of abrasives from West to East, particularly from North America, have probably accelerated the efforts of the Eastern bloc toward self-sufficiency, which may be expected in less than 5 years.

The abrasives industry, although physically small, is strategically important. Modern warfare depends for its weapons on an efficient machine industry that is in turn dependent on abrasive products to insure mass precision production. Moreover, since North America, Western Europe, and the Soviet bloc must each in varying degrees import abrasives and abrasive products, the abrasives industry would be of critical importance during a period of global warfare or other emergency.

The term "abrasive" includes a multitude of products -- any substance used to rub off, smooth, wear down, or polish. Abrasives may be hard or soft, coarse or fine; they may consist of pure elements or be complex inorganic compounds; they may be natural substances or artificial, manufactured materials. It is, for the most part, the artificial abrasives -- hard substances formed in electric furnaces at temperatures measured in thousands of degrees -- and the products manufactured therefrom that dominate the field of high-grade abrasives. Natural abrasives, except for diamonds and corundum, play only a minor role in machine operations.

Artificial abrasives may be classified into (a) crude, in the form of large lumps, and (b) grain and powders. The production of crude abrasives is a primary activity of those plants producing fused

aluminum oxide, silicon carbide, or boron carbide in electric furnaces.[1] The crude abrasives industry is concentrated in a few plants, estimated at 39. Grain and powders are obtained by crushing the crude lumps produced in the furnaces and by grading the crushed material according to size of particles into grain, powders, and micro (powder of rigidly controlled grit sizes).

Abrasive products may be classified into bonded products -- wheels, sticks, segments, and the like -- bonded together with materials such as ceramics, resin, rubber, and shellac; coated products made of cloth or paper; and polishing powders. Since coated products and powders are readily produced in all countries, they are of little importance in a strategic study. Bonded products, however, are not so easily manufactured. The process of bonding the abrasive grain together in the form of wheels requires a high degree of technical skill and is the most important end product of the industry. Only a few firms in the world are capable of manufacturing with high precision the myriad products with differing specifications for size, type, bonding, and grain required by the machine industries. Because there are so few plants engaged in the manufacture of bonded abrasives, and even fewer which develop a high-quality product, their continuous operation is thereby rendered increasingly important in sustaining a flow of war materials.

2. World Production.

a. Artificial Abrasives.

Artificial abrasives constitute 80 to 85 percent of world production of the abrasives industry. Virtually all of the output

1. About 56 percent of the silicon carbide and 97 percent of the aluminum oxide are used to make abrasive products. The balance is utilized in producing special refractory by-products which are used in high-temperature furnace linings, cement, crucibles, and electrical resistors. Less than 0.03 percent of all crude abrasives produced is boron carbide, which is used for special polishing powders and abrasive-resistant products.

of artificial abrasives consists of two substances: fused aluminum oxide and silicon carbide. (For an estimate of world production of these two commodities, see Table 1, Appendix II.)

About 60 percent of the crude abrasives is used in the production of bonded products, which consist largely of wheels.[1] The other 40 percent is used in products which, with the exception of powders for polishing and obtaining highest precision, have little strategic significance in the abrasives industry. Precise statistics on the output of wheels are not available from most countries, not even from the country with the largest production--the US. However, world production of wheels may be computed by taking the 1949 world production of crude abrasives, 311,100 short tons (see Table 1, Appendix II), multiplying this by 60 percent, the proportion of crude used for the production of wheels, and adding 16 percent for the weight of the bonding materials (rubber, resinoid, etc.). By this reasonably accurate computation, inasmuch as processing methods are similar the world over, total global production of wheels in 1949 may be estimated at about 223,000 short tons.

The US and Canada produce about half of this total of wheels. The USSR is the world's next largest producer, and, of other Soviet bloc countries, Czechoslovakia and East Germany have sizable outputs, and Hungary has a small production. Producing countries of Western Europe in order of importance are the UK, France, Western Germany, Italy, Sweden, Switzerland, and Austria. The only other countries of any importance that produce wheels are Japan and Australia, and output in both is relatively small.

b. Natural Abrasives.

Corundum is used in a few special operations where its toughness and shape of crystals give better results than the artificial abrasives. Although deposits are widespread over the earth's crust, the cost of production is high in most places, and exploitation,

1. Since a very large percentage of bonded products consists of wheels, bonded products plants are also designated as wheel plants.

accordingly, is quite limited. Corundum is produced in substantial amounts only in the USSR and in the Union of South Africa. Production in the former is estimated to be about 10,000 short tons annually; in the latter, about 3,000 tons.

Diamonds, because of their high cost and scarcity, are used only where extreme hardness not attainable in other abrasives is required. World production of industrial diamonds has in the postwar period averaged around 7.5 to 8.5 million carats per year. Of this total, about 80 to 85 percent is crushing bort, the particular form of diamond used in the production of abrasive products. The source for diamond crushing bort is primarily the Belgian Congo, and production and export are under the authority of the Diamond Corporation, an English syndicate that controls about 95 percent of the world production of diamonds. About 65 percent of the world production of diamond crushing bort in postwar years has been shipped to the US for processing. Diamond wheels are a special product requiring a technique different from that for regular grinding wheels and are produced in separate plants in the US, the UK, the Netherlands, Switzerland, Sweden, and possibly the USSR.

3. North America.

a. Survey of Production.

The US-Canadian abrasives industry[1] far exceeds the rest of the world in output, both in quantity and in quality of product. About two-thirds of the world production of crude abrasives (see Table 1, Appendix II) and one half of the world production of wheels come from North American plants. It should not be inferred, however, that the industry is a large one by US standards.

1. Much of this section has been taken from a confidential report, Abrasives Industry Survey, prepared for the Abrasives Section, Production Division, National Security Resources Board, 1949, by R. Kirkpatrick and W.T. Montague.

On the contrary, at the primary level, the production of crude abrasives, the industry consists of but 13 plants concentrated in 6 areas for the most part near the waterfalls of the Niagara and the lower St. Lawrence tributaries, and, at the secondary level, the production of wheels, three-quarters of the production capacity is grouped at three places -- the Niagara Falls area; Worcester, Massachusetts; and Philadelphia, Pennsylvania.

Though the North American abrasives industry is largely in the hands of US owners, 85 to 90 percent of crude abrasives comes from Canada. Accessibility to large quantities of cheap electric power is a primary factor in the crude abrasives industry, a fact which accounts for the concentration of this industry in Canada. Much of the crude abrasives produced in Canada is brought to the US for crushing and processing to various sizes and quality of grain and powders.

In 1943, when output was at a peak of 284,073 short tons (see Table 2, Appendix II), practically the full capacity of the US-Canadian crude abrasives industry was employed. Capacity was increased during the postwar years and in 1948 reached 332,492 short tons (see Table 3, Appendix II), as compared with an actual output of 219,200 tons (see footnote b, Table 1, Appendix II). As most of the idle capacity is in aluminum oxide facilities, no increase is planned for this commodity. The capacity for silicon carbide, however, is being enlarged and probably reached about 106,000 short tons by the end of 1950. This expansion would increase the total capacity for the US-Canadian crude abrasives industry to 356,500 short tons, considerably more than the peak annual production of 284,073 tons during the war. Further expansion of production could be achieved rapidly in an emergency.

The wheel industry in North America is almost entirely in the US. Annual production in recent years has been about 120,000 short tons. US wheels are of unsurpassed quality, a matter of paramount importance to both domestic and foreign consumers. Manufacturers of wheels in Western Europe, although often able

to produce sufficient quantities, usually lack the ability to produce both the variety and quality of products needed. The range of US products, both by type and by size, is greater than in any other country. As in the case of crude abrasives, US production of wheels also is below capacity, but output could be doubled in a short time.

b. Dependence on External Sources.

North American industry has a high degree of self-sufficiency with respect to abrasives and abrasive products. The machine industries are supplied with US and Canadian products almost exclusively, and the producers of wheels use abrasive grain made in the US and Canada. Only at the initial stage of acquiring raw materials is there any significant importing, limited mainly to three strategic commodities: bauxite, corundum, and diamond crushing bort. The other raw materials, such as petroleum coke and silica sand, which are used in the production of abrasives are obtained from domestic sources except for small quantities of such items as rubber and shellac.

Bauxite ore is the material purchased from abroad in largest amounts for the abrasives industry, being imported from British and Dutch Guiana. During the war, however, with shipping at a premium, the industry was able to meet rapidly expanding requirements without resort to extensive imports of bauxite ore. The primary sources of supply were several localities in the US which, if necessary, could again adequately serve the needs of the North American abrasives industry. Since the war, imports from the Guianas have been stepped up sharply (see Table 4, Appendix II), notwithstanding large workable deposits in the US. The shift in sources is due to postwar improvement in availability of shipping and the comparatively higher quality and lower price of Guiana bauxite.

Virtually all corundum ore used in North America comes from the Union of South Africa (see Table 5, Appendix II). If this supply were interfered with, some corundum could be produced in Canada, but at greatly increased costs, and at best it would be insufficient. Failing this, corundum could be replaced

entirely with artificial abrasives, but only with additional technical work and at the price of efficiency, since to a considerable extent artificial abrasives are not suitable substitutes. Corundum production in the Union of South Africa, now at full capacity, scarcely meets present North American requirements and probably could not be expanded rapidly enough to supply wartime needs.

The third commodity which the US and Canadian abrasives industry must obtain from foreign sources is diamond crushing bort. The southern part of Africa is the only important source, the Belgian Congo being the principal center of production. Less than 2 percent of US imports of diamond crushing bort comes from countries of the Western Hemisphere -- Brazil, Venezuela, and British Guiana, in particular. Total US imports of diamond fragments used for crushing bort, powders, and dust increased from an annual average of 1,527,000 carats in 1935-39 to a peak of 10,445,000 carats in 1944 and fell again to a postwar low of 3,233,000 carats in 1947. The heavy war requirements were met only because, in addition to regular supplies from the Belgian Congo, stocks had accumulated prior to Pearl Harbor in the hands of the Diamond Corporation. Now the situation differs: present inventories are low. Diamond crushing bort is not readily obtainable for current industrial requirements, as present world demand is in excess of production capacity. Nor could requirements ever be entirely satisfied through substitutes. In time of war, as occurred in 1944, North American demand for diamond crushing bort would be several times greater than at present.

In the event of war or other emergency, there would probably be no insurmountable problems in North America regarding artificial abrasives. It should be pointed out, however, that the small number of primary plants and their hydroelectric sources are concentrated in a few areas in Canada which makes them particularly vulnerable. Moreover, North America could not hope to import substantial quantities of abrasives, since the other producing countries of the West depend considerably on the few North American plants. However, barring destruction of facilities, production in North America could keep up with

expanding domestic requirements and at the same time continue to supply allies in need.

4. Western Europe.

a. Survey of Production.

With access to exports from North America, there are no critical shortages of abrasives in Western Europe at the present time. About 40 percent of the requirements of Western Europe for crude abrasives and abrasive grain, as well as a small but important percentage (about 2 percent) of its requirements for wheels, are imported. The foreign sources of artificial abrasives for Western Europe are the US and Canada. For natural abrasives, corundum and diamond crushing bort, Western Europe depends on the southern part of Africa, the corundum ore being processed in the US.

That all of the abrasive products required in Western Europe are not produced within the area is largely a matter of technical incompetence. The greater skills and more advanced knowledge of North American producers cannot be matched except in a few instances. One plant in Norway, for example, the only one outside the US with a sizable export of silicon carbide, makes a high-quality product. French white aluminum oxide, well-known throughout Europe under the trade name of Crystalba, also is of the best quality and in normal times is marketed widely. US subsidiaries producing wheels in the UK turn out products almost comparable with those of the parent corporations, and Swedish wheels are likewise of unusually high quality.

As in North America, production of crude abrasives in Western Europe is concentrated in a few plants, estimated at 19, one of which is in the UK. Seven more plants, all in the UK, crush and grade crude abrasives imported from Canada and the US. In West Germary the crude abrasives industry consists of five plants with a combined capacity of 37,000 short tons (production in 1949 was 21,000 tons), and in France five plants produced 22,000 short tons of crude

abrasives in the fiscal year 1948-49. The remainder of the crude abrasives industry in Western Europe is rather widely scattered. (The distribution of the plants and the estimated capacities for each of the countries is given in Table 6, Appendix II. Output in West Germany has probably been increased since mid-1949, so that unused capacity by now is doubtless smaller than the table indicates.)

A small amount of expansion is occurring within the crude abrasives industry in Western Europe. The Austrians are expanding capacity, with the hope of attaining self-sufficiency in the production of abrasive grain. The French plan to double their capacity of silicon carbide to 600 short tons by 1951 and are building a new aluminum oxide plant. In West Germany, where production of crude abrasives is well under capacity, the restoration of output can be expected to increase with the expansion of Western European arms production.

Every country in Western Europe has at least a small output of wheels, and its wheel industry is considerably more fragmented than the crude. It is impossible to estimate the production capacities for most individual plants or even for many countries. Data on the number of wheel plants per country are available but in some cases are incomplete. The greatest production comes from the UK, where 16 wheel plants turn out abrasive products. Statistics for West Germany indicate the existence of 38 wheel plants, with a combined capacity of 21,600 short tons, although production by June 1950 had risen only to an annual rate of 8,000 tons. The 17 wheel plants in France provide that country's requirements for wheels except for a few special types. Production of wheels in each of the remaining Western European countries varies from moderate to minor importance. Plans for new construction in the wheel industry in Western Europe have not been disclosed, but little expansion of capacity can be expected. However, in West Germany there is some unused capacity available.

b. Dependence on North America.

Since Canadian crude abrasives are so inexpensive and US wheels so superior in quality and variety, Western European traffic

with North America in abrasives has been and will continue to be wholly one-way. The greater part of this traffic is made up of crude abrasives and abrasive grain. Of artificial abrasives currently being used in Western Europe, about 40 percent was imported from North America. US and Canadian exports of crude abrasives and abrasive grain in 1949 were nearly 50,000 short tons, or about 20 percent of production. More than half of these exports went to the UK, and most of the remainder was imported by other Western European countries (see Table 7, Appendix II). Though there is some trade among Western European countries in crude abrasives and abrasive grain, chiefly Norwegian silicon carbide, French aluminum oxide, and West German crude and grain, the quantity is small in relation to total imports from North America. Imports of raw materials for the production of crude abrasives in Western Europe are not large. Deposits of bauxite are found in France, Greece, the Netherlands, Italy, and Yugoslavia, and also small quantities in the UK. Some petroleum coke is imported into Norway from the US.

The machine industries of Western Europe purchase most of their abrasive products, including wheels, from domestic firms. However, imports of wheels from the US, although only about 2 percent of requirements, include special types and sizes for high precision work that are not produced elsewhere. Even in the three countries in the area -- the UK, France, and West Germany -- whose output of wheels substantially covers domestic requirements, there is some need for a continuing supply of special US items. However, the heavy postwar exports of wheels from the US to Western Europe have fallen off, as West Germany is now resuming full production and turning out sufficient quantities of wheels to provide an ample surplus for export (see Table 8, Appendix II).

In the event of a peripheral war of limited action against one or more Satellite countries, Western Europe would not be greatly affected regarding abrasives. Although the loss of such countries as Finland, Yugoslavia, or Greece would have little significance in production, the loss of West Germany would necessitate increased importing from the US. Should widespread destruction of Western European abrasive plants occur in a global

war, the US-Canadian abrasives industry would be hard-pressed to replace simultaneously most of the productive capacity of the UK, West Germany, and France. Should Western Europe be overrun, destruction of its abrasives industry would be advantageous to the US, since the combined Soviet-Satellite production is already insufficient for the needs of the Soviet bloc and will most likely continue so for several years. This shortage in Eastern Europe, in addition to certain special products required in Western Europe which the Soviet industry does not ordinarily manufacture, would preclude the Soviet orbit from effectively supplying Western Europe with abrasives required for production of war materials.

5. Eastern Europe.

a. Survey of Production.

Only three countries in Eastern Europe have a substantial production of abrasives and abrasive products: the USSR, East Germany, and Czechoslovakia. USSR production in 1949 consisted of about 40,000 short tons of abrasives, of which about 10,000 tons were corundum and the remainder artificial abrasives[1] (see Table 1, Appendix II). This output exceeds that of any other European nation but is only about 18 percent of the US-Canadian output. In the USSR there are known to be four furnace plants producing aluminum oxide and silicon carbide and two plants processing corundum from indigenous deposits, and more such plants may actually be in operation. The USSR also is probably the largest producer of wheels in Europe, the output coming from at least six plants. Production, however, is perhaps only one-fourth that of the US and Canada combined. Postwar reports of new products and of elementary improvements in production methods indicate that in many respects the Soviet

1. This estimate is based on 1939 production figures, which have been revised upward in accordance with reported changes in individual plant capacities and reported percentage increases in nation-wide production.

abrasives industry is still far behind the US and Canadian. Furthermore, Soviet use of many different types of grinding machines, built in numerous countries, requires a wide assortment of abrasive products to fit the machines, and the Soviet industry is particularly deficient in variety of products. In order to reduce the large number of types and sizes of wheels needed, the machines are being adapted to certain standards. The Soviets also have developed electrolytic methods of grinding and tool-sharpening that appear to have some merit and that reduce the need for wheels, especially diamond wheels. However, the fact that since 1946 the USSR has not sought to import any diamond wheels from the US indicates that the USSR is producing diamond wheels.

In East Germany the production of abrasives is represented largely by one plant with a sizable output of crude abrasives (about 10,000 short tons annually but with high production costs).

Czech production of aluminum oxide, of much lower quality than prewar, is estimated at 6,500 short tons for 1949. Czechoslovakia is the other large producer of wheels in the Soviet bloc, and the only Satellite with much to export, most of the wheels going to the Soviet Union.

The trend of production of abrasives and abrasive products in the Soviet bloc is upward. Although East German production has fallen off as a result of Soviet control, primarily because of dismantling of plants, output in the USSR proper has risen in the postwar period and will continue to do so. Moreover, primary plant capacity for the production of crude abrasives is being expanded in Czechoslovakia and initiated in Hungary and Poland.

b. Dependence on External Sources.

The major raw materials used in the abrasives industry are found in Eastern Europe, but deposits of corundum ore may possibly be running low, larger deposits having been used up before the war. Silica sand and petroleum coke are both indigenous to the area, and bauxite of abrasive grades is mined in the USSR and Hungary. Very few diamonds are mined in Eastern Europe, but there is doubt whether

diamond wheels are used as extensively in the Soviet bloc as they are in the West.

The production of abrasives and abrasive products by the Soviet bloc has increased at an even faster pace than consumption. Imports by the USSR from the West are confined mainly to specialized abrasive products such as silicon carbide grain and powders in critical sizes and high-precision types of wheels which the USSR has not yet been able to produce. The wheels are mainly rubber bonded types used in ball- and roller-bearing production.

The Satellites, on the other hand, are largely dependent on the West for abrasives. All evidence indicates that the USSR has no surplus of abrasive products to supply its allies. The US and Norway were the primary sources of supply of silicon carbide for Czechoslovakia and East Germany, and it has been increasingly difficult for them to obtain their requirements (approximately 3,000 short tons per year in the case of Czechoslovakia), because of US export controls and the Norwegian system of allocating exports in accordance with prewar trade patterns. Norwegian allocations have been far less than the quantities sought by the Soviets in trade negotiations. White aluminum oxide also is purchased by Czech industries from the UK and France, the latter supplying the well-known Crystalba, procurable only in small quantities since the war. Canada also has sold some crude abrasives to Czechoslovakia. Polish requirements for abrasives, all of which must be imported, are from 500 to 1,000 short tons annually. The Polish-Swiss trade agreement for 1949-50 provided for Swiss exports to Poland of 300 short tons of silicon carbide. Presumably much of the balance of Poland's abrasives requirements is procured from Czechoslovakia. Hungary must import her entire requirement of abrasive grain. Requirements of Rumania and Bulgaria are quite small and, except for the most elementary items, must all be imported.

US and Canadian export controls on abrasive items have made it difficult for the Soviet bloc to obtain sufficient silicon carbide and

certain types of wheels. Other abrasives and abrasive products, however, are readily available from Western European producers and have generally replaced US products, although some firms in Switzerland, the Netherlands, and Austria, among others, have been re-exporting US products. Adequate information on exports of abrasives from the West to the Soviet bloc is lacking. However, it is known that the USSR, in addition to importing Norwegian silicon carbide, has imported wheels from Switzerland. Wheels also have been supplied to the USSR in smaller quantities by other Western European exporters. At least 300 tons of Austrian wheels went to Eastern Europe in 1949.

In the event that war or other emergency should cut off Western European abrasive exports, the Satellite machine industry, particularly in Czechoslovakia, East Germany, Hungary, and Poland, would probably be disrupted, at least for several months. There would be no alternative source which could supply the necessary products until Soviet production could be expanded. It appears probable, however, that in less than 5 years, the Soviet bloc could become completely self-sufficient in abrasives except for industrial diamonds. Attainment of this objective would be delayed somewhat by the necessity of producing efficient abrasives-manufacturing equipment which the USSR has been trying to import. Other problems in attaining self-sufficiency would be the manufacture of special abrasive products which the Soviet engineers are not yet competent to make.

APPENDIX I

COUNTRY STUDIES

1. Western Europe.

a. Austria.

In prewar years Austria did not produce abrasive grain but relied chiefly on Germany. Since World War II it has been the policy of the Austrian government to make the country self-sufficient in abrasives. In 1946 an aluminum oxide plant with a capacity of 1,500 short tons was established in a chemical works at Seebach-bei-Villach in Carinthia. Recently another plant with a 200-ton capacity was built by the leading Austrian producer of wheels. Both of these plants, however, cannot meet requirements of the well-established Austrian wheel industry, so that there is still a reliance on imports of aluminum oxide. Although there is as yet no domestic production of silicon carbide, a plant is expected soon. There are five plants producing wheels, three of the largest having a combined capacity of 3,000 to 4,000 metric tons.

A considerable export business has developed between Austria and countries of the Eastern bloc. In 1949, about 300 metric tons of wheels destined for Eastern Europe were officially reported but were not all Austrian, being largely re-exports manufactured elsewhere in the West.

b. Belgium.

Abrasive grain is not produced in Belgium, but one large plant and six small plants produce wheels of the rough and snagging types used principally in foundries. Annual output is about 900 metric tons. Belgian imports of bonded products in 1949 totaled 442 tons; exports, 280 tons.

c. Denmark.

Abrasive grain is not produced in Denmark, but two small plants produce wheels for domestic machine industries. Imports in 1948 were 400 metric tons of abrasive grain and 360 metric tons of wheels and stones. Principal suppliers were Sweden, Czechoslovakia, the UK, and Norway.

d. Finland.

Finland's requirements of high-quality abrasives are small, and only ordinary wheels of non-precision type are produced. Imports in 1947 included approximately 200 metric tons of wheels and 360 metric tons of abrasive grain. Principal suppliers, in order of importance, were the UK, the US, Sweden, Norway, Denmark, France, Czechoslovakia, Belgium, Switzerland, and Canada. A large percentage of the wheels required by Finland is used in the production of wood pulp.

e. France.

The French crude abrasives industry, with a capacity exceeding 22,000 metric tons, is second only to the West German industry in output. Three plants, with a combined capacity of 15,000 short tons, produce regular aluminum oxide; another plant, with a capacity of 4,000 tons, produces white aluminum oxide; and still another plant, with a capacity of 3,000 tons, produces silicon carbide. Annual production statistics are not available, but it is known that a shortage of electric power has curtailed production somewhat in the postwar period. French white aluminum oxide, well-known throughout Europe under the trade name of Crystalba, is of the highest quality. Formerly, 50 percent of production was exported, and at present, even with limited production, some exports are maintained to keep contact with former markets. The principal importers are Switzerland, the UK, the Benelux countries, Norway, Italy, and Sweden. Czechoslovakia is the only country outside Western Europe with sizable imports of Crystalba. Some abrasive grades of bauxite, of which the

Marseilles area has the best in Europe, also are exported. Production capacity for aluminum oxide is being considerably increased by the addition of a new plant under construction. Although the French must still import most of their requirements of silicon carbide, present plans for doubling production of domestic silicon carbide by 1951 will alleviate this shortage. Some boron carbide also is produced.

The wheel industry in France consists of 17 plants. Except for a few special types, production takes care of domestic requirements. Production in 1949 probably exceeded 12,000 metric tons. Aside from the products of the sole US-owned plant, the quality of wheels is only average. Small quantities of white aluminum oxide wheels are exported, but most wheels are sold to domestic machine industries.

f. Germany, West.

In prewar years Germany ranked first in Europe as a producer and exporter of abrasives, and the substantial rate of output was nearly doubled during the war. In 1943, about 58,000 short tons of abrasive grain, of which 46,000 tons were aluminum oxide and 12,000 silicon carbide, were produced by nine plants.

After the postwar division into zones of occupation the German abrasives industry was about equally divided between West and East Germany. That portion of the industry remaining in West Germany is quite extensive, five crude abrasives plants being located in the territory at the time of division. The capacity for the production of aluminum oxide is estimated at 28,800 short tons, and that of silicon carbide at 7,800 short tons. Output was quite low until 1949, a symptom of the disruption of the economy. In 1950, however, there was a remarkable increase in production, and German abrasive products are again appearing in world markets. Output is now only slightly below prewar, current annual production being estimated at 15,000 tons of aluminum oxide and 6,000 tons of silicon carbide. There also is one plant producing boron carbide in grades suitable for honing and polishing. The rate of production is approximately 8 short tons annually, about half the US rate.

In acquisition of wheel plants West Germany fared a little better. Of Germany's peak wartime production of wheels, 36,000 metric tons in 1943, only 40 percent came from territory now in the Soviet Zone. In West Germany there are 47 wheel plants, the combined output of which had recovered by the end of 1949 to 6,900 tons. Production in June 1950 had risen to an annual rate of 8,000 tons. Furthermore, as armament production in Western Europe increases, production of abrasives in West Germany can be expected to keep pace. Because total capacity of the industry, 27,000 metric tons, is well above present output, a good deal of slack can be utilized whenever the demand increases.

The quality of production in West Germany is at present below standards. Most raw materials must be imported. Materials from East Germany are no longer available. Furthermore, some postwar disorganization and inadequate technical control still impair production.

With increasing production, West German exports have risen. It is estimated that exports of abrasive grain in 1950 will reach 2,400 short tons of silicon carbide and 4,800 short tons of aluminum oxide. Exports of wheels are expected to be about 800 metric tons, or 10 percent of production. Shipments of crude abrasives and wheels go to both Eastern and Western European countries. While quality is inferior to US and UK products, prices are much lower. Regular and white aluminum oxide and silicon carbide have been offered in Sweden at about 40 percent below US-delivered prices, and wheels in Switzerland at considerably below US and UK prices. Were it not for export controls, the West German industry would once more be a principal supplier of abrasives to Eastern Europe.

g. Italy.

The Italian crude abrasives industry consists of one company that has two plants producing abrasive grain. Production capacity is 8,840 short tons, of which 8,000 is for aluminum oxide and 840 for silicon carbide. Production in 1948 was 4,800 tons of aluminum oxide and 510 tons of silicon carbide. Because the industry uses domestic bauxite of low grade, the quality of aluminum oxide produced

is one of the poorest in the world. Italian boron carbide, produced by one chemical company, also is low-grade.

There are eight wheel plants in Italy, the most important being a subsidiary of a US corporation. A wide range of types and sizes of wheels is produced, but, with a few exceptions, they are poor in quality.

Italy is not self-sufficient in abrasives. Total imports of abrasive grain and products were 1,498 metric tons in 1948. A breakdown of import-export statistics is not available, but the principal imports of abrasives were 678 tons of abrasive grain and 96 tons of precision wheels from the US. Other imports of abrasives come from Switzerland, Germany, and Czechoslovakia. Exports of abrasive grain and products are small, totaling only 115 metric tons in 1948, 109 tons of which went to Yugoslavia.

h. Netherlands.

The importance of the Netherlands in world abrasives markets is in production of diamond abrasives, some of which are exported to the Soviet bloc as well as to Western countries. Abrasive grain is not produced in the Netherlands, and there are only two small plants that produce wheels. The completion of a larger, more modern wheel plant was expected before the end of 1950, with import requirements of about 275 metric tons of abrasive grain annually. Currently, most wheels used by Dutch machine industries are imported. Imports in 1948 were 690 metric tons of wheels and 248 metric tons of abrasive grain, wheels being imported mainly from the US and the UK, and abrasive grain from the US, Switzerland, and Norway.

i. Norway.

The Norwegian abrasives industry is important only as a producer of high-quality silicon carbide. Norway's entire production, 8,000 short tons in 1949, a typical postwar year, comes from one US-owned plant. Norway is the only country, except the US and Canada, with a sizable surplus of silicon carbide, and ordinarily over 90 percent of the output is exported (see Table 9, Appendix II).

Since the imposition of export controls on US abrasives, the demand in Western and Eastern Europe for the Norwegian product has been heavier, and the industry has been forced to resort to some extent to allocation of exports in accordance with sales during previous years. In 1950, Norway ceased shipments entirely to the USSR and Czechoslovakia and allotted far less to Poland than was requested (see Table 9, Appendix II).

In 1949 the production of three small Norwegian wheel plants was about 600 metric tons. The output consisted of most types of wheels, and the quality was fair. In 1948, wheels were exported to France, Belgium, Czechoslovakia, and the USSR.

j. Portugal.

Portugal's requirements of high-quality abrasives are small. Two wheel plants manufacture products only of the lowest type, suitable for the blacksmith and hardware trades. Imports of wheels in 1948, mainly from the UK, totaled 96 metric tons.

k. Spain.

Spain's requirements of high-quality abrasives are small. Three wheel plants, with a total capacity of about 1,000 metric tons, produce vitrified wheels of poor quality.

l. Sweden.

The Swedish crude abrasives industry consists of one plant, which in 1949 produced 1,200 short tons of silicon carbide and 2,000 short tons of aluminum oxide. A second plant once produced about 1,000 tons of aluminum oxide per year but discontinued operations in 1947 either because of a power shortage or because of unsatisfactory results.

The Swedish wheel industry turns out a product unexcelled anywhere in Europe or Asia. Only US wheels are on the whole superior to the Swedish product, which is on a par with the British.

Six plants, which provide over half of the nation's requirements, manufacture wheels in a wide range of types and sizes, including rubber bonded. One plant also produces diamond wheels.

Swedish imports of abrasives in 1949 included about 1,900 metric tons of aluminum oxide and silicon carbide and 360 tons of wheels from the US, as well as 800 tons of silicon carbide from Norway. About 300 metric tons of wheels were exported in 1948.

m. Switzerland.

The importance of Swiss abrasive products is in their high quality. Production of crude abrasives is limited to one silicon carbide plant with a capacity of 3,000 short tons. Its annual exports have recently averaged about 2,000 tons. The principal customers are France, Italy, Austria, Denmark, West Germany, and the Satellite countries -- Czechoslovakia, Hungary, Poland, and East Germany. Although aluminum oxide has been produced in experimental quantities by an aluminum company and also by a chemical concern, neither has marketed the product.

There are six producers of wheels in Switzerland, only one of which has large capacity. Although their combined output is less than 1,000 metric tons of wheels annually, all major classes of wheels except rubber bonded are produced. There also are three producers of diamond wheels in Switzerland. Certain specialities, such as small precision wheels, are comparable in quality to the best US wheels. About 20 percent of Swiss production is exported, Belgium, Italy, and the Netherlands being the largest purchasers.

Some 250 metric tons of wheels are imported annually by Switzerland from the US, West Germany, the UK, Czechoslovakia, and Belgium. About 1,500 tons of abrasive grain also are imported annually, the principal sources being the US, France, the UK, Norway, and West Germany.

n. United Kingdom.

The UK has the greatest output and highest quality of abrasive products in Western Europe. Seven plants crush and grade crude

abrasives. Although there is some domestic production of white aluminum oxide, over 85 percent of the crude abrasives consumed in British processing plants is imported from North America because of the lower production costs, particularly in Canada, where electric power is cheap. However, in the case of the purest and highest-priced grade of white aluminum oxide, the factor of power rates is not of the same importance. Because of a shortage of electric power, production in the UK was discontinued during the war, and even now output is relatively small because demand is not great. As a rule, white aluminum oxide accounts for something like 12 percent of the total UK consumption of crude abrasives. Boron carbide also is produced in small amounts.

Eighteen plants in the UK manufacture wheels, the ones with the highest-quality products and also the greatest output being US subsidiaries. The products of these US-owned plants are comparable in quality, variety, and precision to US products and are generally superior to other European products with the exception of the Swedish. Most British abrasive products are used by domestic machine industries. For example, of the 35,000 short tons of wheels and other abrasive products produced in 1948, only 2,400 tons were exported. The UK also is an important producer of diamond wheels.

o. Yugoslavia.

Yugoslavia has one small furnace for production of aluminum oxide and one wheel plant with a capacity of about 300 metric tons producing low-grade wheels. Annual requirements of abrasives are estimated to be 500 to 1,000 metric tons. Imports of abrasive grain in 1947 from the US and Norway totaled 220 tons; of wheels from the US, 135 tons. Good abrasive grades of bauxite are mined and exported to Western countries.

2. Eastern Europe.

a. Bulgaria.

Output of abrasive products in Bulgaria consists of stones and wheels of very inferior quality. Annual Bulgarian requirements of

abrasives are estimated at 200 to 300 metric tons.

b. Czechoslovakia.

Czechoslovakia was the first European country to produce abrasives. Early in the twentieth century the Czechs built and operated abrasive furnace plants and abrasive products plants in Dresden, Germany, and in La Bathie, Savoie, France, and a wheel plant in Moscow. These plants, as well as one abrasives plant and two abrasive products plants within Czechoslovakia, were built by the United Carborundum and Electric Works of Benatky. In the years between the wars a Czech plant also produced carborundum but was dismantled by the Germans after they took over the Norwegian carborundum production.

In 1947 the United Carborundum and Electric Works contracted with a leading US producer for the plans and specifications of an abrasive products plant with a capacity of 6,000 metric tons of wheels when operating on a single-shift and 15,000 metric tons on a three-shift basis. Erection of the plant proceeded very slowly in 1948 and 1949, but inquiries sent out early in 1950 for the purchase of machinery indicate that the work is now progressing at a faster rate. Delays may have been due to lack of sufficient furnace capacity for raw material.

In 1948 the Czechs erected a plant for refining and grading crude silicon carbide. Imports of silicon carbide from Norway since 1949 have all been of crude abrasives. The high cost of electric power probably makes it uneconomic to produce silicon carbide, but the refinery makes it possible to utilize cheap imported crude. In July 1948 the Czechs made inquiry in the US for plans for a silicon carbide furnace plant and a processing plant and for technical aid in the production of silicon carbide. They are probably considering producing their own requirements in spite of high costs. In 1948 they also were striving to regain possession of their Dresden abrasives plant, dismantled by the Soviets.

There is no production of white aluminum oxide or silicon carbide in Czechoslovakia, but output of regular aluminum oxide

grain in 1949 was about 6,500 short tons. White aluminum oxide is bought from the UK and France. In 1950 a new furnace plant of 12 furnaces for aluminum oxide was under construction, as compared with only 7 furnaces now in operation. This new installation may almost triple 1949 capacity. Because of limitations on exports of silicon carbide from the US and Norway, Czechoslovakia has been hard-pressed to obtain its annual requirements of 3,000 short tons.

The Czech industry produces a wide variety of abrasive products. Wheels are, for the most part, of the vitreous type. No rubber bonded wheels are produced. Reports indicate that postwar production is not so high in quality as prewar, one important reason being that available bonding materials lack the variety necessary for quality production. Also, many skilled workers have found employment elsewhere. Furthermore, the bauxite, which is imported from Hungary, is not of the best abrasive grade, being high in iron content.

Czechoslovakia is the only country in the Soviet bloc that has a surplus of abrasive products for export, and the USSR gets the largest share. Whereas exports to the Balkans were large in 1948, they are no longer a major factor in Balkan trade. Exports to Italy have been bartered for ball bearings. With long experience in the production of abrasives, the Czechs should be able to give valuable technical aid to other Satellite countries.

c. Germany, East.

Of the three crude abrasives plants in East Germany before the war, the two most modern were almost completely dismantled by the Soviets. These two plants had a combined wartime capacity of 5,600 short tons of aluminum oxide grain and 7,100 short tons of crude silicon carbide, equal to 12 percent and 60 percent respectively, of German production. The large aluminum oxide plant not dismantled has a capacity of 15,000 tons and produces about 10,000 tons annually. This plant is an old one, and production costs are high. One of the other plants has been partially re-equipped and is producing 1,200 to 1,800 tons of aluminum oxide. In 1949, only about 1,200 short tons

of silicon carbide -- a poor grade hardly usable for abrasives -- were produced in a chemical plant. In 1950, production probably exceeded 3,500 tons.

At the end of the war there were eight wheel plants of importance in East Germany. Three of the largest and most modern, with a combined capacity of 7,760 metric tons of wheels, or 22.5 percent of peak wartime German production, were completely dismantled. After dismantling, they were re-equipped at about 25 percent of their former capacity. Present wheel capacity in East Germany is about 4,600 metric tons, which is below requirements, and the plants operate at only about 85 percent of capacity, producing some 3,900 tons annually. Silicon carbide for use in the plants must be imported. The quality of the wheels is poor as compared with that of the prewar period.

d. Hungary.

Although production of bauxite of abrasive grade in Hungary is large, there is no production of abrasive grain. The Five-Year Plan stated that an aluminum oxide plant, to be a part of the gigantic Almasfuzito alumina works, was to be started in 1950. In 1949 the Hungarian government negotiated with a German firm in Berlin for a number of electric furnaces with a capacity of 1,500 kilo-volt-amperes per furnace to be used in this plant.

There are several wheel plants in Hungary, the largest of which has a capacity of 300 metric tons per year. Catalogs indicate that a fairly complete assortment of wheels is produced. Some were exported to the Netherlands and Rumania in 1948.

Annual Hungarian requirements for abrasive grain appear to be about 1,000 metric tons. The 1950 trade agreement with East Germany provides for imports of 500 metric tons of aluminum oxide grain and 10 tons of wheels, as well as unspecified amounts of silicon carbide.

e. Poland.

The Polish government has allotted 1.5 billion zlotys for the establishment of abrasives and ball-bearing industries. Abrasive

grain is not produced in Poland, but plans were made in 1950 to begin production of aluminum oxide and silicon carbide at the Ratibor plant in Silesia. Furnaces and electrodes for this plant were purchased in 1949. The only wheel plant produces wheels of poor quality. Annual Polish requirements for abrasive grain are estimated at 500 to 1,000 metric tons. The Polish-Swiss trade agreement of 1949-50 provides for Swiss exports to Poland of 300 tons of silicon carbide.

f. Rumania.

Output of abrasive products in Rumania consists of stones and wheels of very inferior quality. The largest wheel plant has a capacity of 48 metric tons per year. Formerly, US wheels were imported, but recent imports have come from East Germany and Czechoslovakia. Small quantities of abrasive grain also are imported. Annual Rumanian requirements of abrasives are estimated at 200 to 300 metric tons.

g. USSR.

Information on the more important abrasives plants in the USSR is so fragmentary that in most instances it has been impossible to make any summary of plant capacity, recent production, and quality. Those details which appear to be reasonably accurate follow.

(1) Chelyabinsk Abrasives Combine, Chelyabinsk, Chelyabinsk Oblast.

Plant construction at Chelyabinsk was started in 1932, and production capacity by 1936 was 6,000 metric tons of aluminum oxide and 14,500 metric tons of wheels. In 1942 the number of furnaces for the production of crude abrasives had been increased to six with a capacity of 10,000 tons of aluminum oxide. During the war, equipment from the Imeni Ilyich Abrasives Plant and two small plants in Luga, Leningrad Oblast, were moved to Chelyabinsk. In May 1946 the plant's output of wheels was at an annual rate of 9,000 tons. Production in 1948 was 110 percent of "planned" value, but only 50 of the 148 items projected were made. Raw material for the production of aluminum oxide is received from the Chelyabinsk bauxite processing plant.

(2) Zaporozh'ye Carborundum Plant, Zaporozh'ye, Ukrainian SSR (also reported as Dnepropetrovsk).

An electric furnace plant for silicon carbide was built at Zaporozh'ye in 1935-39 at a reported cost of 5.3 million rubles. A fair grade of silicon carbide reportedly was produced in 1936, though the plant was still under construction at the beginning of 1940. The furnace design and capacity of the prewar plant are reported to have been the same as the Norwegian silicon carbide plant, which has a capacity of 8,000 metric tons. The Zaporozh'ye plant was damaged during the war, and restoration was begun in 1946. The Soviet press in 1949 characterized it as the largest carborundum plant in the USSR.

(3) Imeni Ilyich Abrasives Plant, Leningrad.

This plant ranks with the Chelyabinsk Abrasives Combine as one of the two most important producers in the USSR. The plant was founded in 1930 and expanded in the 1932-37 period and again in 1939. After the war, construction was started on a much larger scale on an entirely new plant with new equipment, including a modern tunnel kiln, and building was still going on in 1949. Before the war, 3,000 workers were employed, but employment in 1949 was slightly over 2,000.

Prewar production included both aluminum oxide and silicon carbide. The 1934 production plan was 3,300 metric tons of aluminum oxide and 1,000 metric tons of silicon carbide grain. The new plant produces only aluminum oxide, at a rate of about 3,600 metric tons a year.

Wheel production in 1948 was 5,510 metric tons. The wheels produced are mainly vitreous bonded, some bakelite bonded, and a few rubber bonded, but the quality and range of sizes and types are still inadequate. In 1947, 20 to 30 percent of the wheels produced was rejected. In 1949 this percentage was reduced through technical help received from the Leningrad Experimental Abrasives Plant. Reports in 1948 and 1949 mention new developments in production that have been in use in the US for many years, such as the introduction of titanium oxide as a part of the furnace raw material in the production of aluminum oxide. Furthermore, improvements in the molding of wheels resulted in the saving of 30 to 40 percent of valuable corundum. A method of producing wheels of high porosity also was developed.

Abrasive materials used by the plant include (a) black and green silicon carbide from the Tashkent Carborundum Factory, (b) corundum from Semiz-Bugu, Karaganda Oblast, and from the Akmolinsk Oblast in Kazahk SSR, and (c) emery.

(4) Tashkent Carborundum Plant, Tashkent, Uzbek SSR.

In 1948, production at this electric furnace plant near Tashkent was about 6,000 metric tons of silicon carbide and 500 metric tons of white aluminum oxide. In 1946, production was started on small quantities of boron carbide and on very fine white aluminum oxide powder known at the factory as micro powder. Earlier reports indicated that the USSR was in short supply of fine powdered abrasives for honing and finishing operations.

The plant controls quartzite mines in the vicinity, and the Aktash corundum mines are located very near Tashkent, mines in the Karaganda and Pavlodar Oblasts being a few miles north. Whether corundum is the raw material used in the production of white aluminum oxide is not known. The plant, which has four sets of electric furnaces (four furnaces per set), of which the last set was installed in 1947, requires about 30 metric tons of sulfuric acid and 700 metric tons of anthracite, local coal, and oil coke per month.

(5) Kyshtym Graphite and Corundum Combine, Kyshtym, Chelyabinsk Oblast.

Plant construction at Kyshtym was started in 1932, and production in 1936 was 6,000 metric tons of corundum and 4,000 metric tons of graphite. Corundum and bauxite mines are found in the vicinity of Kyshtym, and new deposits of corundum were discovered in 1944. A subsidiary plant is located at Techenskoye (15 miles from Kyshtym).

(6) Semiz-Bugu Corundum Processing Plant, Bayan-Aul, Pavlodar Oblast, Kazakh SSR.

This plant processes corundum from mines in the vicinity of Pavlodar and Karaganda. Operation began in 1918, and output in

1932 was 1,750 metric tons. Corundum is shipped to the Imeni Ilyich Abrasives Plant, Leningrad, and possibly to other plants.

(7) Moscow Abrasives Plants, Moscow.

Little is known about production of abrasives in the Moscow area. A plant established many years ago in Moscow by the United Carborundum and Electric Works of Benatky, Czechoslovakia, produced low-grade vitrified snagging, foundry, and hardware types of wheels. One report states that a Moscow plant was extended and reconstructed in 1939. Another report states that the "Balashikha" plant produced 3,000 metric tons of abrasive products in 1943. A recent report describes a small plant producing wheels and powders under the name of Moscow Abrasives Plant.

(8) Tashkent Abrasives Plant, Tashkent, Uzbek SSR.

This plant produces abrasive products and uses raw material from the Tashkent Carborundum Plant located nearby. Products include a wide variety of vitreous and bakelite bonded wheels of aluminum oxide and silicon carbide, segments, sticks, coated products, and polishing and lapping boron carbide. Production in 1947 was 950 metric tons; about 5 percent of 1948 production was rejected because of weak bonding and incorrect balance of wheels (rejects after shipment are not included). In December 1948 the plant employed 440 persons, of whom about 330 were engaged in production.

(9) Siberian Abrasives Plant, Khaita, Irkutsk Oblast.

Wheels are the main product of this plant. The plant is well-equipped, new machinery having arrived from Leningrad in 1946 and early 1947. Production in 1948 was 3,780 metric tons, and the plant employed 1,160 industrial and 400 nonindustrial workers.

(10) Zlatoust (near Chelyabinsk), Chelyabinsk Oblast.

Two plants for abrasive products are located in Zlatoust. Wheels were produced as early as 1923 from domestic and imported

abrasive grain. Experiments were conducted in 1927 on the production of aluminum oxide. A recent report mentions wheel production.

(11) Krasny Tigel Abrasives Plant, Luga, Leningrad Oblast.

This plant was probably dismantled during the war. A recent report states that it is producing abrasive lapping paste.

(12) Other possible plants on which no recent or definite information is available are as follows:

(a) Shuya Grinding Wheel Plant, Shuya, Ivanovo Oblast, Central Industrial Region.

A plant for production of bonded and coated products, including rubber bonded wheels, was under construction at this location in 1940.

(b) Khait Abrasives Plant, Khait, Garm Oblast, Tadzhik SSR.

A new factory at this location may have produced emery wheels and other abrasives products in 1944.

(c) Smychka Abrasives Plant, Luga, Leningrad Oblast.

A wheel plant was removed from this location during the war. There is no information on its present status.

3. Far East.

a. Australia.

Crude abrasives are not produced in Australia, and abrasive grain is imported from the US, the UK, and Norway. Imports in 1949 included 1,470 short tons of abrasive grain and 36 short tons of wheels from the US, and 136 metric tons of silicon carbide from Norway. Imports from the UK were undoubtedly higher than from the US. Total requirements might, therefore, exceed 3,000 short tons.

b. India.

India has a small wheel industry, but production costs are very high. In order to protect the industry, the import duty on wheels and segments was increased in 1949 from 80 to 100 percent ad valorem.

c. Japan.

Japan has 11 plants producing a good quality of green and black silicon carbide and poor-quality regular and white aluminum oxide. Production in 1949 was 1,500 metric tons of aluminum oxide, 800 metric tons of silicon carbide, and 6,000 metric tons of wheels, sufficient for present requirements, as compared with prewar production of 4,800 tons of abrasive grain and 8,400 tons of wheels. Peak production during the war was 25,600 metric tons of abrasive grain and 24,000 metric tons of wheels. The range of types and sizes of wheels produced is, however, very limited. During prewar years, Japan imported about 2,000 tons of abrasive grain from the US and Germany. Prewar imports of wheels were very small and included only a few special types and sizes.

d. Korea.

There is an aluminum oxide furnace plant in operation north of the 38th Parallel, but its output has not been determined.

4. Other Countries.

In unindustrialized countries of Europe, Asia, Latin America, and Africa, there is practically no production of abrasives. The order of importance of these countries as importers of US abrasives is as follows: Argentina, India, Union of South Africa, Brazil, Mexico, Chile, and Cuba.

APPENDIX II

TABLES

Table 1

World Production
of
Aluminum Oxide and Silicon Carbide a/
1949

Short Tons

Area	Aluminum Oxide	Silicon Carbide	Total
North America			
US and Canada b/	125,900	67,500	193,400
Total, North America	125,900	67,500	193,400
Western Europe (Fiscal Year 1948-49)			
France	19,000	3,000	22,000
West Germany	15,000	6,000	21,000
Norway	c/	8,000	8,000
Italy	4,800	500	5,300
UK	3,600	-	3,600
Sweden	2,000	1,200	3,200
Switzerland	c/	3,000	3,000
Austria	1,500	-	1,500
Total, Western Europe	45,900	21,700	67,600
Eastern Europe (Estimate)			
USSR	16,000	14,000	30,000
East Germany	10,000	1,300	11,300
Czechoslovakia	6,500	-	6,500
Total, Eastern Europe	32,500	15,300	47,800
Japan	1,500	800	2,300
World Total	205,800	105,300	311,100

a/ Includes less than 100 tons of extremely hard boron carbide used mainly in the form of powders for special polishing operations and in molded form as nozzles to resist abrasion.

N.B. Footnotes b and c follow on p. 33.

Table 2

Production of Crude Abrasives
US and Canada
1943

Product	US	Canada	Short Tons Total
Silicon Carbide	15,870	51,409	67,279
Aluminum Oxide	22,889	193,905	216,794
Total	38,759	245,314	284,073

Table 3

Capacity of Crude Abrasives Industry
US and Canada
1948

Product	US	Canada	Short Tons Total
Silicon Carbide	17,700	64,300	82,000
Aluminum Oxide	27,192	223,300	250,492
Total	44,892	287,600	332,492

(Footnotes continued from Table 1, p. 32.)

b/ Separate production figures for the US and Canada are not available for 1949. About 12 percent of the crude abrasives is produced in the US and 88 percent in Canada. In 1948, production was as follows:

	Aluminum Oxide	Silicon Carbide	Total
Canada	140,500	52,600	193,100
US	13,900	12,200	26,100
Total	154,400	64,800	219,200

c/ Insignificant quantities produced.

Table 4

Consumption of Bauxite
by
US Abrasives and Refractory Industries
1945-49

Short Tons

Source	1945	1946	1947	1948	1949
US	187,355	182,582	204,781	125,030	126,355
Guianas	13,827	22,798	54,478	122,277	77,086
Total	201,182	205,380	259,259	247,307	203,441

Table 5

US Imports
of
Corundum Ore and Concentrates
1937-39, 1944-48

Short Tons

Source	1937-39 a/	1944 b/	1945	1946	1947	1948
South Africa	3,153	5,220	4,120	2,801	2,350	3,566
Others	24	1,240	2,124	1,181	51	46
Total	3,177	6,460	6,244	3,982	2,401	3,612

a/ Peak wartime imports.
b/ Yearly average for 3-year period.

Table 6

Capacity for Production
of
Crude Abrasives in Western Europe a/
1949

Area	Number of Plants in Operation 1949	Production Fiscal Year 1948-49	Capacity 1949
		Short Tons	
West Germany	5	21,000	37,000
France	5	22,000	22,000 b/
Italy	2	5,300	8,840
Norway	1	8,000	8,000
Sweden	2	3,200	4,200
UK	1	3,600	3,600 c/
Switzerland	1	3,000	3,000
Austria	2	1,500	1,700 d/
Total	19	67,600	88,340

a/ All figures are estimated.
b/ The figure of 22,000 tons for France is based on the assumption that output in 1948-49 was at full capacity. There is evidence, however, that a shortage of electric power kept production below capacity, so that this figure may be low. A new plant is now under construction.
c/ The one abrasives producing plant in the UK should not be confused with the seven plants which process crude imported from the US and Canada.
d/ Since Austria plans to become self-sufficient in abrasives, capacity may have been increased by now above the estimate of 1,700 tons.

Table 7

North American Exports of Artificial Abrasives
Crude and Grain
1949

Short Tons

Importing Area	US	Canadian	Total
UK	8,100	25,000	33,100
France	3,800	-	3,800
Italy	2,000	-	2,000
Sweden	1,900	-	1,900
Belgium	1,300	100	1,400
Austria	1,000	-	1,000
West Germany	600		600
Switzerland	200	300	500
Western Europe, Others	500	-	500
Total, Western Europe	19,400	25,400	44,800
All Other Countries	3,700	600	4,300
Total, US Exports	23,100	26,000	49,100

Table 8

US Exports of Artificial Abrasive Wheels
to Western Europe
1947-49

Short Tons

Importing Country	1947	1948	1949
Sweden	1,409	841	357
Netherlands	332	263	264
Italy	40	96	237
France	141	62	128
Belgium	170	191	107
Switzerland	101	90	98
Norway	130	43	55
UK	31	49	52
Finland	68	26	26
Portugal	54	10	2
Others	20	38	46
Total	2,496	1,709	1,372

Table 9

Norwegian Sales of Silicon Carbide
Domestic and Foreign
1948-50

Area	Metric Tons			Percentage of Total Sales		
	1948	1949 a/	1950 b/	1948	1949	1950
Norway	672.0	715.1	673.8	9.5	9.0	7.8
UK	2,253.3	2,724.1	3,232.5	31.5	34.1	37.5
Sweden	836.4	1,200.4	1,482.8	11.8	15.0	17.2
Denmark	161.0	209.6	207.4	2.3	2.6	2.4
US and Canada	919.7	196.0	720.4	12.9	2.5	8.4
Australia	135.8	109.9	108.0	1.9	1.4	2.1
Subtotal	4,978.2	5,155.1	6,424.9	69.9	64.6	75.4
Netherlands	81.2	130.9	105.9	1.1	1.6	1.2
Belgium-Luxembourg	452.8	643.2	421.5	6.3	8.1	4.9
France	94.9	364.6	257.5	1.3	4.6	3.0
Switzerland	243.9	125.4	202.0	3.4	1.6	2.3
Austria	79.3	34.5	185.0	1.1	0.4	2.1
Spain	-	30.0	58.0	-	0.4	0.7
Italy	-	17.1	167.9	-	0.2	1.9
Germany (East and West)	-	121.3	526.0	-	1.5	6.1
Subtotal	952.1	1,467.0	1,923.8	13.2	18.4	22.2
USSR	420.0	454.0	-	5.9	5.7	-
Czechoslovakia	520.9	616.9	-	7.3	7.7	-
Poland	174.4	100.8	75.0	2.4	1.3	0.9
Yugoslavia	44.5	57.0	60.0	0.6	0.7	0.7
Finland	53.4	65.0	66.6	0.7	0.8	0.8
Subtotal	1,213.2	1,293.7	201.6	16.9	16.2	2.4
Miscellaneous	5.5	62.0	2.0	-	0.8	-
Total	7,149.0	7,977.8	8,552.3	100.0	100.0	100.0

a/ 1949 sales constituted 3,948 tons of grain and micro, 2,792 tons of crude, 320 tons of powders, and 917 tons of refractory. Sales to Czechoslovakia were all of crude. Shipments to other countries of Eastern Europe were entirely of grain and micro.

b/ Decreased sales to countries of the Eastern bloc in 1950 reflect the effects of Western pressure on Norway to comply with export restrictions on shipments of strategic materials to countries of the Eastern bloc and the embargoes on Norway to comply with these restrictions.

APPENDIX III

NAMES AND LOCATIONS OF IMPORTANT PLANTS

1. Austria.

Treibacher Chemische Werke AG Seebach-bei-Villach Carinthia (British Zone)	Built in 1946; original capacity, 1,500 tons of low-grade aluminum oxide; being expanded to 4,000-5,000 tons in 1950, primarily for higher-grade products.
Rappold Schleifmittel Industrie KG Plants at — Strobachgasse 6 Vienna 5 (British Zone)	Largest wheel producer in Austria; made recent addition to wheel plant for production of 200 tons of aluminum oxide; wheel capacity, 1,200 tons (no rubber or shellac wheels).
Seebach-bei-Villach Carinthia (British Zone)	Wheel capacity, 1,200 tons.
D. Swarovski, Glassfabrik & Tyrolit Schleifmittelwerke Wattens Tirol (French Zone)	Built in 1936; furnace equipment badly damaged; not expected to resume production of furnace products; wheel capacity, 1,200 tons.
"ALPINA"-Schleifscheibenfabrik Karl Kisling Effingergasse 26-28 Vienna 16 (French Zone)	Wheel capacity, 450 tons.
Arthur Lebert Nachf. A. Hopf Schleifscheibenfabrik Ameisgasse 28 Vienna 14 (French Zone)	Wheel capacity, 100 tons.

2. Belgium.

Société Anon. des Meules Duchâteau 15-17, avenue Georges Rodenbach Schaerbeek (near Brussels)	Wheels, stones, and sticks; 1949 production: silicon carbide, 1,200 tons; aluminum oxide, 1,400 tons.
Éts. Th. Kluft Mortsel (near Antwerp)	Wheels.
Société des Meules et Abrasifs ("SOMEA") 60, rue Gillon Brussels	Wheels.
Meules Belga Van den Heckestraat 28 Ledeberg (near Ghent)	Wheels.
Compagnie Industrielle des Abrasifs ("CIA") 24, rue Volta Marcinelle-Charleroi Hainaut	Wheels and stones.
R. Goffard rue Leman Ans (near Liége)	Wheels.
Sohy Frères Sauvenière (near Gembloux)	Wheels.
Creuven-Wegnez 17, rue Jardon Verviers	Wheels and stones.
Société Anon. Éts. Preud'homme Frères 110, rue Léon Grosjean Evere (near Brussels)	Wheels.

3. Czechoslovakia.

United Carborundum and Electric Works, National Corporation (Spojené Závody na Výrobu Karborunda a Elektritu Národní Podnik) Benatky nad Jizerou Bohemia	Largest wheel producer in Czechoslovakia; aluminum oxide capacity, 8,000 tons; 1949 production, 6,500 tons; in 1948 facilities added for crushing and refining imported crude silicon carbide; new aluminum oxide processing plant of 6,000 tons' capacity (single-shift basis or 15,000 tons on three-shift basis) being built; during prewar years silicon carbide also produced but facilities dismantled during the war.
Ostrit Schleifscheiben- & Schleifmittelwerk Dr. P. Wertheimer KG Jindřišská 7 Prague	Wheels.

4. Denmark.

Nordisk Slibeskive Fabrik Skolegade 19 Valby Copenhagen	Largest abrasives producer in Denmark; wheels and bricks of aluminum oxide and silicon carbide.

5. Finland.

Oy Karla AB Nickby (Nikkilä)	Wheels of silicon carbide and aluminum oxide.
Tammer Tehtaat Oy Tampere	Wheels of emery and garnet.
Oy Hangö Cementgjuteri AB Hangö	Wheels and bricks of emery and silicon carbide.

Karpokivi Oy Helsinki	Stones of silicon carbide.
Kuusamon Kivitehdas Kuusamo	Wheels.

6. France.

Société d'Électro-Chimie, d'Électro-Métallurgie et des Aciéries Électriques d'Ugine 10, rue Général Foy Paris Plant at — La Bathie Savoie	1948 capacity and production, 3,000 tons of silicon carbide (50 percent each of abrasive and refractory grades); capacity to be doubled by 1951; aluminum oxide capacity 4,000-5,000 tons; 1948 production, 3,500-4,000 tons of white aluminum oxide, 99.5% pure, highest quality in Europe.
Société Électro-Chimique de Mercus Mercus-Garrabet Paris	
Société Anon. l'Achromine Jarrie	These three plants produce regular aluminum oxide; combined capacity, approximately 20,000 tons; 1948 production, approximately 15,000 tons.
Abrasifs du Sud-Ouest ("ASO") 23 bis, rue de Balzac Paris Plant at — Sarrancolin	
Compagnie des Meules Norton La Courneuve Paris	Wheels of silicon carbide and aluminum oxide; capacity, 4,720 tons; 1948 production, 4,597 tons.
Éts. G. Durrschmidt Société Lyonnaise des Émeris 14, chemin de Montbrillant Lyon	Wheels of silicon carbide and aluminum oxide; capacity, 1,825 tons; 1948 production, 1,778 tons.

Société des Meules Artificielles ("SAMA") 62, rue Victor Hugo Courbevoie Paris	Wheels and stones of silicon carbide and aluminum oxide; capacity, 832 tons; 1948 production, 810 tons.
Éts. Fours Rousseau, Société Anon. 116 bis, Quai de Bezons Argenteuil (near Paris)	Wheels of silicon carbide and aluminum oxide; capacity, 788 tons; 1948 production, 768 tons.
Éts. A. Huard 53-59, rue des Périchaux Paris 15	Wheels and stones; capacity, 616 tons; 1948 production, 600 tons.
Compagnie Centrale des Émeris et Tous Abrasifs ("CETA") 133-135, boulevard Sérurier Paris 19 Plant at — Courbevoie Paris	Wheels and stones; capacity, 540 tons; 1948 production, 526 tons.
Vve. Denis Poulot Fils 48-50, avenue Philippe Auguste Paris 11	Wheels and stones; capacity, 108 tons; 1948 production, 105 tons.
Éts. Henri Essig 41, rue Victor Nancy	Wheels and stones; capacity, 380 tons; 1948 production, 370 tons.
Ars, Société Industrielle 12, rue Ch. Floquet Montrouge Paris	Wheels and stones; capacity, 380 tons; 1948 production, 370 tons.
Scandaletos 36, boulevard Bastille Paris 12	Wheels (reclaimed); capacity, 54 tons; 1948 production, 53 tons.
Meules Artificielles Vitrifiées Éts. Paul Barré 49-51, rue Hoche Issy-les-Moulineaux (near Paris)	Dental wheels; capacity, 380 tons; 1948 production, 370 tons.

OK 4 rue des Portevins Paris	Wheels; capacity, 379 tons; 1948 production, 370 tons.
Fortin et Saunier 36, rue Sedaine Paris 11	Rubber wheels and polishing products; capacity, 38 tons; 1948 production, 37 tons.
R. Adrian Saint-Didier-en-Velay	Wheels.
Éts. Kahn 3, rue l'Espagnol Paris 20	Wheels.
A. de Burnay, Meules Diamantes 9, passage Thiéré Paris 11	Wheels.
Éts. P. Henry 21, rue Favorites Paris	Wheels.
Société Industrielle des Meules en Émeri Paris	Wheels.
Éts. Deplanque Aîné, Meules, Émeri Maisons-Alfort Paris	Wheels.
Deplanque Fils, Jeune, Meules Artificielles 8, rue Léon-Frot Paris 11	Wheels.
Société OMIP 94, boulevard Beaumarchais Paris 11	Wheels.

Somata Abrasifs 20, rue de Conflans Charenton Paris	Wheels.

7. Germany.

a. East Germany (Soviet Zone).

Elektroschmelze Zschornewitz Saxony-Anhalt	Very old, inefficient plant; wartime aluminum oxide capacity, 15,000 tons; 1949 production, 8,000-11,000 tons.
Electroschmelzwerk AG Mueckenberg Saxony	Dismantled by Soviets; wartime capacity, 6,000 tons of raw silicon carbide, but lacked crushing and refining equipment.
Schleifscheibenfabrik Dresden-Reick AG Dresden	Wartime capacity, 1,500 tons of aluminum oxide and 700 tons of silicon carbide; silicon carbide facilities dismantled by the Soviets; 1949 production, about 1,800 tons of wheels made from aluminum oxide produced at the plant.
SAG Stockstoffwerk Piesteritz Piesteritz-bei-Wittenberg Brandenburg	Formerly Bayerische Stickstoffwerke AG; made first attempts to produce silicon carbide in 1948-49; equipment may have been obtained from the dismantled Dresden-Reick plant; July 1949 production rate, 1,200 tons per year of very low-grade silicon carbide, hardly suitable for abrasives but used mainly as refractory; report of November 1950 indicates production has increased to 3,000-3,600 tons.

Edwin Becker Schleifmittelwerk Berlin-Hermsdorf	Bonded products.
Capillar-Schleifscheiben-Werke Crosta-ueber-Bautzen	Bonded products.
Dorfnerwerk Inh. Dr.-Ing. Josef Dorfner Velten-bei-Berlin	Bonded products.
Eibenstocker Schleifscheiben-fabrik, Ing. German & Co. Eibenstocker	Bonded products.
Carl Hinne Leipziger Naxos-Schmirgelscheiben-Fabrik Boehlitz-Ehrenberg/Leipzig	Bonded products; capacity, 1,200 tons.
"Oemeta" Chemische Werke GmbH Berlin W 15	Bonded products.
Orion Schleifmittelwerk Max Frey Berlin N 65	Bonded products.
Rottluff-Schleifscheibenfabrik AG Chemnitz 17	Bonded products.
Schmirgelwerk Dr. Rudolf Schoenherr Chemnitz 13	Bonded products; capacity, 360 tons.

b. West Germany.

Lonzawerke Elektrochemische Fabriken GmbH Waldshut South Baden (French Zone)	Aluminum oxide capacity, 7,200 tons; 1949 production, 2,400-3,000 tons; silicon carbide capacity, 3,000 tons; 1949 production, 1,200-1,500 tons.

MSO Maschinen & Schleifmittelwerke AG Offenbach-am-Main Hesse (US Zone)	Aluminum oxide capacity, 6,000 tons; 1949 production, 3,000 tons; 1948 wheel capacity, 1,800 tons.
Elektroschmelzwerk Kempten AG Kempten Bavaria (US Zone)	Silicon carbide capacity, 4,800 tons; 1949 production, 4,800 tons; plant being expanded; also produces boron carbide.
Feldmuehle AG, Werk Koholyt Wesseling-bei-Koeln North Rhine-Westphalia (British Zone)	Aluminum oxide capacity, 12,000 tons; 1949 production, 6,000 tons; bonded products; capacity, 3,600 tons.
Hermann Starck Ferrowerk Rhina AG Laufenberg South Baden (French Zone)	Aluminum oxide capacity, 3,600 tons; 1949 production, 2,000-2,500 tons.
F.W. Beckmann GmbH Solingen North Rhine-Westphalia (British Zone)	Bonded products.
Ernst Kircher Schleifmittelwerk Pforzheim Wuerttemberg-Baden (US Zone)	Bonded products.
Bergisches Schleifmittelwerk Fritz Gauterin GmbH Solingen-Wald North Rhine-Westphalia (British Zone)	Bonded products; capacity, 360 tons.
Naxos Schmirgel-Schleifwaren-fabrik Burkhard & Co. Frankfurt-am-Main/West Hesse (US Zone)	Bonded products.

Butzbacher Schleifmittelwerke Butzbach Hesse (US Zone)	Bonded products.
Degussa Gold- und Silber-scheidenanstalt Neurod Hesse (US Zone)	Bonded products; capacity, 360 tons.
Deutsche Carborundum-Werke GmbH Duesseldorf-Reisholz North Rhine-Westphalia (British Zone)	Bonded products; capacity, 3,000 tons.
Deutsche Norton GmbH Wesseling-bei-Koeln North Rhine-Westphalia (British Zone)	Bonded products; capacity, 4,200 tons.
Dilumit-Werk GmbH Duesseldorf North Rhine-Westphalia (British Zone)	Bonded products; capacity, 240 tons.
Diskus-Werke AG Frankfurt-am-Main Hesse (US Zone)	Bonded products.
Dorfnerwerk Hirschau, Oberpfalz Bavaria (US Zone)	Bonded products.
Eichler & Co. Neu-Isenburg Hesse (US Zone)	Bonded products.

Fickert & Winterling KG Marktredwitz Bavaria (US Zone)	Bonded products.
Fontaine & Co. GmbH Frankfurt-am-Main Hesse (US Zone)	Bonded products.
Peter Fuchs Ransbach, Westerwald Rhineland-Palatinate (French Zone)	Bonded products.
Gewerkschaft Elsa Bochum North Rhine-Westphalia (British Zone)	Bonded products.
Guilleaume-Werk Beuel-am-Rhein North Rhine-Westphalia (British Zone)	Bonded products; capacity, 1,800 tons.
Jota-Werk Gebr. Funke AG Duesseldorf North Rhine-Westphalia (British Zone)	Bonded products.
Hahn & Kolb Stuttgart Wuerttemberg-Baden (US Zone)	Bonded products.
Hermann Hilmer Inh. E. Aust Witten North Rhine-Westphalia (British Zone)	Bonded products.

Keramische Schleifscheiben-fabrik, Karl Krebs & Riedel Karlshafen Hesse (US Zone)	Bonded products.
Kurt Landenberger Stuttgart-Untertuerkheim Wuerttemberg-Baden (US Zone)	Bonded products.
P. Lapport & Sohn Enkenbach Rhineland-Palatinate (French Zone)	Bonded products.
Th. Leisse & Co. Meschede North Rhine-Westphalia (British Zone)	Bonded products.
Naxos-Union Schleifmittel- und Schleifmaschinenfabrik Frankfurt-am-Main Hesse (US Zone)	Bonded products; capacity, 2,000 tons.
"Naxos-Elektro" Schmirgel- und Corundfabrikate Wilhelm Kramer KG Nidda Hesse (US Zone)	Bonded products.
Naxos-Schmirgelwerk Mainkur GmbH Hanau-am-Main Hesse (US Zone)	Bonded products.
Richartz Schleifmittel AG Solingen-Ohligs North Rhine-Westphalia (British Zone)	Bonded products; capacity, 360 tons.

August Rueggeberg Werkzeug- und Maschinenfabrik Marienheide North Rhine-Westphalia (British Zone)	Bonded products.
Schleifmittelwerk Bietigheim Friedrich Elbe Bietigheim Wuerttemberg-Baden (US Zone)	Bonded products.
Schleifscheibenfabrik Dresden-Reick Prym KG Duesseldorf North Rhine-Westphalia (British Zone)	Bonded products.
Schleifscheibenfabrik Alfons Schmeier Helmbrechts, Oberfranken Bavaria (US Zone)	Bonded products.
Schleifmittel-Werk Karl Seiffert Vertriebs-GmbH Hilden-bei-Duesseldorf North Rhine-Westphalia (British Zone)	Bonded products; capacity, 1,800 tons.
Schleifscheibenwerk Frankenwald Seyffert & Co. Schauenstein, Oberfranken Bavaria (US Zone)	Bonded products.
Friedrich Schmaltz GmbH Offenbach-am-Main Hesse (US Zone)	Bonded products.
Schmirgelwerk Ludwigshafen Carl Lebert Ludwigshafen South Baden (French Zone)	Bonded products.

C.F. Schroeder, Schmirgelwerke KG Hannoversch-Muenden Lower Saxony (British Zone)	Bonded products.
Hermann Schwarzhaupt & Soehne Luedenscheid North Rhine-Westphalia (British Zone)	Bonded products.
Dr. Sievers & Co. GmbH Mehlem-am-Rhein North Rhine-Westphalia (British Zone)	Bonded products.
Stella-Schleifscheibenwerke Robert Buchner KG Marktredwitz Bavaria (US Zone)	Bonded products.
Tyrolit-Schleifmittel-Ges. Zaehringer Stuttgart/West Wuerttemberg-Baden (US Zone)	Bonded products.
Westdeutsche Schmirgel- und Schleifmittel-Fabrik Derkom & Co. GmbH Solingen-Wald North Rhine-Westphalia (British Zone)	Bonded products.
WIDIA-Fabrik Essen North Rhine-Westphalia (British Zone)	Bonded products.
Winterling-Keramik, Winterling & Co. Schwarzenbach-an-der-Saale Bavaria (US Zone)	Bonded products.

Karl Fickert KG, Maschinen- und Schleifscheibenfabrik Schwarzenbach-an-der-Saale Bavaria (US Zone)	Bonded products.

8. Hungary.

(Name and location of plant unknown)	Planning in 1949 to start production of aluminum oxide in 1950; in June 1949 negotiation being carried on in Berlin for purchase of a number of electric furnaces of 1,500 kilo-volt-amperes capacity.
"Widenta" Védjegyo Gyártmányok Nyar-út 7 Budapest VIII	Wheels.
Solus Csiszolókronggyár b.t. József Antal Jünger Liget-u 11 Budapest X	Wheels.
Stieber Csiszolókoronggyár r.-t. Csurgói-út 28 Budapest XI	Wheels.
Naxos Csiszolóárugyár r.-t. Budafok	Wheels.
István Kossányi Kiss József-u 53 Budapest V	Wheels.
Ferenc Velty Fia. Veszprem	Wheels.
Arnin Rosner Fiumei-út 12/A Budapest VIII	Wheels.

Adolf Kanitz & Co. Budapest	Wheels.

9. Italy.

Soc. An. Fratelli Galtarossa Verona Plants at -- Domodossola and Trento	Capacity: aluminum oxide, 8,000 tons; silicon carbide, 840 tons; 1949 production: aluminum oxide, 4,800 tons; silicon carbide, 500 tons; also produces low-grade boron carbide in small quantities.
Soc. Mole Norton Corsico (Milan)	Wheels.
Soc. Italiana Mole Abrasivi Ermoli Malnate (Varese)	Wheels.
Fabbrica di Mole Bottaccini Padua	Wheels.
Soc. Italiana dello Smeriglio Bovisa (Milan)	Wheels.
Astese Fabbricazione Abrasivi, Soc. An. Asti	Wheels.
Soc. An. Industria Mole Via Dalmazia 1 Padua	Wheels.
Manifatture del Seveso Via Bertini 32 Milan	Wheels.
"ABRAX" Industria Mole Smeriglio Vicenza	Wheels.
Compagnia Italiana Abrasivi ("CIA") Cusano Milanino	Wheels.

Furher Rho	Wheels.

10. Japan.

a. Kanto Denki Kogyo KK Gunma	
b. Nihon Corundum KK Oji	
c. Showa Denko KK Shiojiri	
d. Taisho Denki Seirensho Kashiwabara	In 1949, aluminum oxide and silicon carbide produced in plants c and h; aluminum oxide only produced in plants a, b, e, i, and k; silicon carbide only produced in plants d, f, g, and j; 1949 production, 1,500 tons of aluminum oxide and 800 tons of silicon carbide, which is about half of prewar and one-tenth of maximum wartime production.
e. Nihon Bando Kogyo KK Kambara	
f. Nihon Soda KK Iwase	
g. Nihon Jinzokokuen KK Sasazu	
h. Nihon Kenmazai Kogyo KK Sakai	
i. Rasa Kogyo KK Osaka	
j. Fukuyama Denki KK Chemical Plant (Location of plant unknown)	
k. Ujiden Kagaku Kogyo KK Abrasives Plant (Location of plant unknown)	

11. Korea.

(Name and location of plant unknown)	Aluminum oxide plant in operation in Hungnam area, latitude 39°50' N - longitude 127°38' E; capacity and production unknown.

12. Netherlands.

Nederlandse Slijpsteenindustrie Jannink & Co. N.V. Haaksbergerstraat 103 Enschede	Wheels; new and largest plant.
Eerste Nederlandsche Slijpsteenenfabriek Niasstraat 17 Amsterdam	Wheels.

13. Norway.

Arendal Smelteverk A/S Eydehamn Aust-Agder	Production and capacity, 8,000 tons of silicon carbide; sole producer in Norway; US-owned subsidiary; produces best grade of silicon carbide in Europe.
Den Norske Slipeskivefabrik A/S Oslo	
Foss Slipeskivefabrik A/S Fetsund Akershus	Wheels and stones of silicon carbide, corundum, and aluminum oxide; 1948 production of these three companies, 541 tons.
Norrøna Fabriker A/S Porsgrunn Telemark	

14. Poland.

Ratibor Silesia	Plant for production of aluminum oxide and silicon carbide under construction; furnaces and electrodes purchased in 1949.

Vogt & Co. Wapienica Silesia	Wheels.

15. Portugal.

Fábrica de Mós de Esmeril Vieira Pinto & Cia. Ltd. Paços de Brandão	Wheels of silicon carbide and aluminum oxide.

16. Spain.

Fabregat José Pino Avenida José Antonio Primo de Rivera 679 Barcelona	Wheels.
Industrias Abrasivas Soc. An. Valencia	Wheels.
Alberdi y Cia. Mondragon Guipúzcoa	Wheels.

17. Sweden.

Höganäs-Billesholms AB Höganäs Malmöhus	Aluminum oxide and silicon carbide; new furnace capacity being installed; capacity: aluminum oxide, 1,000-2,000 tons; silicon carbide, 900-1,200 tons.
AB för Kemisk och Elektrokemisk Production Avesta Västmanland	Until 1947 produced about 1,000 tons of silicon carbide; operation discontinued.
AB Svenska Smergelskiffabriken Höganäs Malmöhus	Wheels.
Baltiska Slipskive AB Häverödal Stockholm	Wheels.

Svea AB, Slipskivefabriken Norrtälje Stockholm	Wheels.
Industri AB Solid Örebro	Wheels.
Slimaverken Almhult Kronoberg	Wheels.
Svenska Diamantbergborrnings AB Stockholm	Diamond wheels.

18. Switzerland.

Gotthardwerke AG fuer Elektrochemische Industrie (Subsidiary of Lonza-Elektrizitaetswerke Chemische Fabriken AG) Gampel	
Plant at —	
Bodio	Capacity, about 3,000 tons of silicon carbide.
Aluminium-Industrie AG Lausanne	During the war produced about 100 tons of crude white aluminum oxide.
Karbidwerk Spoerry Flums St. Gallen	Produced small experimental quantity of aluminum oxide but discontinued the project.
Schweizerische Schmirgel-scheibenfabrik AG (Swiss Emery Wheel Works Ltd.) Winterthur	Only large abrasive products plant in Switzerland; silicon carbide and aluminum oxide wheels and stones.
Gripp Schleifscheibenwerk Dietikon (near Zurich)	Wheels.

Schleifwerkzeuge Burgdorf Dr. Bosshard & Co. Burgdorf	Wheels.
H. Studer Birmensdorf	Wheels.
C. Martinelli Schleifscheiben- fabrik Buchs Aargau	Wheels.
Sarubin, Société Anon. Biel-Bienne	Wheels.
A. Vogel's Soehne AG Pieterlen	Diamond wheels.
Diametal AG Biel	Diamond wheels.
Swiss Jewel Co. Soc. An. Locarno	Diamond wheels.

19. United Kingdom.

Universal Grinding Wheel Co. Ltd. Stafford	White aluminum oxide, 2,000 tons, and wheels of aluminum oxide, silicon carbide, and diamonds; also has a crushing plant.
Thomas Firth & John Brown Ltd. Sheffield	Boron carbide.
Carborundum Co. Ltd. Trafford Park Manchester	Wheels of aluminum oxide, silicon carbide, and diamonds; also has a crushing plant.
Norton Grinding Wheel Co. Ltd. Welwyn Hertfordshire	Wheels of aluminum oxide, silicon carbide, and diamonds; also has a crushing plant.
Luke & Spencer Ltd. Broadheath Altrincham Cheshire	Wheels of aluminum oxide, silicon carbide, and diamonds; also has a crushing plant.

Thos. Goldsworthy & Sons Ltd. Manchester	Crushing plant for aluminum oxide.
Lancashire Grinding Wheels Ltd. Padiham Lancashire	Wheels of aluminum oxide and silicon carbide; also has a crushing plant.
Geo. Jowitt & Sons Ltd. Lescar Lane Sheffield	Wheels of aluminum oxide and silicon carbide.
Abrafract Ltd. Beulah Road Owlerton Sheffield	Wheels of aluminum oxide and silicon carbide.
Abrasive Products Ltd. Hare Street Bilston Staffordshire	Wheels of aluminum oxide and silicon carbide.
Anglo Abrasive Works Ltd. Alperton Lane Wembley Middesex	Wheels of aluminum oxide and silicon carbide.
Mitchell Emery Wheel Co. Ltd. Openshaw Manchester	Wheels of aluminum oxide and silicon carbide.
Pollett Bros. Ltd. Waterloo Works & Wellington Foundry Burton-on-Trent Staffordshire	Wheels of aluminum oxide and silicon carbide.
Stacey's Abrasive Wheels Ltd. Heeley Sheffield	Wheels of aluminum oxide.
A.A. Tattersall & Co. Ltd. Mill Hill Emery Works Blackburn Lancashire	Wheels of aluminum oxide and silicon carbide.

Turret Grinding Wheel Co. Ltd. Fordbridge Road Sunbury-on-Thames Middlesex	Wheels of aluminum oxide and silicon carbide.
Wizard Abrasives Ltd. North Anston (near Sheffield) Yorkshire	Wheels of aluminum oxide and silicon carbide.
Arcorundum Grinding Wheel Co. 52, Finchfield Road Wolverhampton Staffordshire	Wheels of aluminum oxide and silicon carbide.
Lap (CI Process) Ltd. Palace Wharf Rainville Road Hammersmith London, W 6	Wheels of silicon carbide.
Anderson Grice & Co. Ltd. Carnoustie Scotland	Wheels of silicon carbide.
The Impregnated Diamond Products Ltd. Gloucester	Diamond wheels.
A.C. Wickman Ltd. Coventry	Diamond wheels.
Pearl Manufacturing Co. 2, Mount Pleasant London, WC 1	Diamond wheels.
Sir James Farmer Norton Adelphi Ironworks Salford	Diamond wheels.
Whistlers Diamond Tool Co. Ltd. 2, St. Mary's Street Gloucester	Diamond wheels.

20. USSR.

Chelyabinsk Abrasives Combine Chelyabinsk Chelyabinsk Oblast	1949 production, 10,000 tons of aluminum oxide; wheel production probably exceeds 1936 production, 14,500 tons.
Zaporozh'ye Carborundum Plant Zaporozh'ye Ukrainian SSR	1949 production, about 8,000 tons of silicon carbide.
Imeni Ilyich Abrasives Plant Leningrad	1940 production, 6,000 tons of aluminum oxide and large production of abrasive wheels; 1948 wheel production, 5,150 tons; 1950 aluminum oxide production, 3,600 tons.
Tashkent Carborundum Plant Tashkent Uzbek SSR	1949 production, 6,000 tons of silicon carbide, 500 tons of white aluminum oxide, and some boron carbide.
Kyshtym Graphite and Corundum Combine Kyshtym Chelyabinsk Oblast	Natural corundum processing plant; 1936 production, 6,000 tons of corundum.
Semiz-Bugu Corundum Processing Plant Bayan-Aul, Pavlodar Oblast Kazakh SSR	1932 production, 1,750 tons of corundum.
Moscow Abrasives Plant Moscow	Grinding wheels and grinding powders.
Tashkent Abrasives Plant Tashkent Uzbek SSR	Grinding wheels and other abrasive products.
Khait Abrasives Plant Khait, Garm Oblast Tadzhik SSR	New factory at this location produced grinding wheels in 1944.

Siberian Abrasives Plant Khaita Irkutsk Oblast	1948 production, 3,780 tons of grinding wheels.
Smychka and Krasny Tigel Abrasives Plants Luga Leningrad Oblast	Two plants in Luga dismantled during the war; Krasny Tigel plant now producing abrasive paste; no information available on the present status of the Smychka plant.

Other possible plants of which little is known and which may not now be in existence are as follows:

Balashikha Abrasives Plant Moscow	Grinding wheels; 1943 production, 3,000 tons; this may be the Moscow Abrasives Plant.
Shuya Grinding Wheel Plant Shuya, Ivanovo Oblast Central Industrial Region	Plant under construction in 1940.
Zlatoust (near Chelyabinsk) Chelyabinsk Oblast	Two old plants probably located here.

21. Yugoslavia.

Ruse (near Maribor)	Nitrogen factory; aluminum oxide reported to have been first produced in December 1948; Yugoslavia has abrasive grade bauxite, produces aluminum oxide and aluminum, and has endeavored to employ German technicians of the abrasive industry.
F. Svati Maribor	Wheel plant; capacity, 300 tons.

SECRET

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